CLAIMS

What is claimed is:

1. A method of forming a barrier layer on a surface of a semiconductor device structure, comprising:

providing a semiconductor substrate;

forming a dielectric layer over the semiconductor substrate, the dielectric layer having at least one trench;

selectively depositing a metallization layer in the at least one trench; and

forming a barrier layer overlying the metallization layer and the dielectric layer, the barrier layer comprising at least one conductive portion and at least one nonconductive portion.

2. The method of claim 1, wherein forming a dielectric layer over the semiconductor substrate comprises forming the dielectric layer from an oxide compound, an aerogel, or a polymer.

3. The method of claim 2, wherein forming a dielectric layer over the semiconductor substrate comprises forming the dielectric layer from a polymer selected from the group consisting of a foamed polymer, a fluorinated polymer, and a fluorinated-foamed polymer.

4. The method of claim 2, wherein forming a dielectric layer over the semiconductor substrate comprises forming the dielectric layer from polyimide.

5. The method of claim 2, wherein forming a dielectric layer over the semiconductor substrate comprises forming the dielectric layer from silicon oxide.

6. The method of claim 1, wherein selectively depositing a metallization layer in the at least one trench comprises selectively depositing copper or a copper alloy.

7. The method of claim 1, wherein forming a barrier layer overlying the metallization layer and the dielectric layer comprises depositing a metal layer over the metallization layer and the dielectric layer.

8. The method of claim 7, wherein depositing a metal layer over the metallization layer and the dielectric layer comprises depositing a metal selected from the group consisting of titanium, zirconium, and hafnium.

9. The method of claim 7, wherein depositing a metal layer over the metallization layer and the dielectric layer comprises depositing the metal layer by low energy implantation or chemical vapor deposition.

10. The method of claim 7, wherein depositing a metal layer over the metallization layer and the dielectric layer comprises selecting an implant energy so that the metal penetrates a surface of the metallization layer and the dielectric layer.

11. The method of claim 10, wherein selecting an implant energy so that the metal penetrates a surface of the metallization layer and the dielectric layer comprises selecting the implant energy to be from about 0.1 keV to about 2.0 keV.

12. The method of claim 7, wherein depositing a metal layer over the metallization layer and the dielectric layer comprises selecting the implant energy so that the metal penetrates a depth of about 5Å to about 50Å into the metallization layer and the dielectric layer.

13. The method of claim 7, wherein forming a barrier layer overlying the metallization layer and the dielectric layer comprises reacting at least a portion of the metal layer with nitrogen to form the barrier layer.

14. The method of claim 7, wherein forming a barrier layer overlying the metallization layer and the dielectric layer comprises exposing the metal layer to a nitrogen atmosphere.

15. The method of claim 14, wherein exposing the metal layer to a nitrogen atmosphere comprises exposing the metal layer to the nitrogen atmosphere for an amount of time sufficient to incorporate nitrogen into at least a portion of the metal layer.

16. The method of claim 14, wherein exposing the metal layer to a nitrogen atmosphere comprises exposing the metal layer to nitrogen, nitric oxide, nitrous oxide, or ammonia.

17. The method of claim 14, wherein exposing the metal layer to a nitrogen atmosphere comprises exposing the metal layer to a nitrogen plasma or a rapid thermal nitrogen treatment.

18. The method of claim 1, wherein forming a barrier layer overlying the metallization layer and the dielectric layer comprises forming the at least one conductive portion over the metallization layer and the at least one nonconductive portion over the dielectric layer.

19. The method of claim 18, wherein forming the at least one conductive portion over the metallization layer comprises reacting nitrogen with the metal layer to form at least one metal nitride portion.

20. The method of claim 18, wherein forming the at least one nonconductive portion over the dielectric layer comprises reacting the metal layer with the dielectric layer to form at least one metal oxide, metal oxynitride, metal carbide, or metal carbonitride portion.

21. A method of forming a barrier layer on a surface of a semiconductor device structure, comprising:

providing a semiconductor substrate;

forming a dielectric layer over the semiconductor substrate, the dielectric layer having at least one trench;

selectively depositing a metallization layer in the at least one trench;

depositing a metal layer overlying the metallization layer and the dielectric layer;

exposing the metal layer to a nitrogen atmosphere; and

forming a barrier layer overlying the metallization layer and the dielectric layer, the barrier layer comprising at least one conductive portion and at least one nonconductive portion.

22. The method of claim 21, wherein depositing a metal layer overlying the metallization layer and the dielectric layer comprises depositing a metal selected from the group consisting of titanium, zirconium, or hafnium.

23. The method of claim 21, wherein depositing a metal layer overlying the metallization layer and the dielectric layer comprises depositing the metal layer by low energy implantation or chemical vapor deposition.

24. The method of claim 21, wherein depositing a metal layer overlying the metallization layer and the dielectric layer comprises selecting an implant energy so that the metal penetrates a surface of the metallization layer and the dielectric layer.

25. The method of claim 24, wherein selecting an implant energy so that the metal penetrates a surface of the metallization layer and the dielectric layer comprises selecting the implant energy to be from about 0.1 keV to about 2.0 keV.

26. The method of claim 21, wherein depositing a metal layer overlying the metallization layer and the dielectric layer comprises selecting the implant energy so that the metal penetrates a depth of about 5Å to about 50Å into the metallization layer and the dielectric layer.

27. The method of claim 21, wherein exposing the metal layer to a nitrogen atmosphere comprises exposing the metal layer to the nitrogen atmosphere for an amount of time sufficient to incorporate nitrogen into at least a portion of the metal layer.

28. The method of claim 21, wherein exposing the metal layer to a nitrogen atmosphere comprises exposing the metal layer to nitrogen, nitric oxide, nitrous oxide, or ammonia.

29. The method of claim 21, wherein exposing the metal layer to a nitrogen atmosphere comprises exposing the metal layer to a nitrogen plasma or a rapid thermal nitrogen treatment.

30. The method of claim 21, wherein forming a barrier layer overlying the metallization layer and the dielectric layer comprises forming the at least one conductive portion over the metallization layer and the at least one nonconductive portion over the dielectric layer.

31. The method of claim 30, wherein forming the at least one conductive portion over the metallization layer comprises reacting nitrogen with the metal layer to form at least one metal nitride portion.

32. The method of claim 30, wherein forming the nonconductive portion over the dielectric layer comprises reacting the metal layer with the dielectric layer to form at least one metal oxide, metal oxynitride, metal carbide, or metal carbonitride portion.